



The Golden Ratio

Background Research

- 1.** In your own words explain the Golden Ratio. Your explanation should include any symbols and rules.

Answers will vary: The Golden ratio is a special number which is the calculation

of the ratio between 2 numbers such that when the total is divided by the larger number, this will be the same as when the larger is divided by the smaller and equals 1.618 rounded to 3 decimal places. The Golden Ratio is also represented by the Greek letter “phi” or ϕ . The golden Ratio is also known by many names including: golden mean, golden number and divine proportion.

- 2.** Show how it is calculated mathematically by using an example.

$$a/b = (a+b)/a = 1.618... \quad \frac{a}{b} = \frac{a+b}{a} = 1.618...$$

eg let $a = 160$ and $b = 98.88752$

$$\frac{160}{98.88752} = \frac{160+98.88752}{160} = 1.68$$

- 3.** Give 3 examples of where the Golden Ratio is found in nature or otherwise.

Some examples are: The Parthenon in Greece (ratio of width to height), the Fibonacci sequence (ratio between 2 successive numbers), of a pine cone (ratio between the two spirals from the centre)

Preparation

- 4.** Watch Video no. 6 from the ‘CensusAtSchool Classroom Activities and Support Materials’ then ‘Professional support materials’ pages or follow the link below. NB we are interested in the second presenter.
<http://www.abs.gov.au/websitedbs/CaSHome.nsf/Home/Professional+Development+Videos+Entry+Page>

In this video Ian Wong, the presenter, asks whether the relationship between belly-button height and height conforms to the Golden Ratio.

Ian then uses features of Excel to help him organise the data to investigate whether it is true or not.

He starts by asking: “Can you estimate a person’s height from their belly-button height?” and, “The first step is to establish if a relationship exists between height and belly-button height. If a relationship does exist we can estimate a person’s height if we know their belly-button height.”

This video then explores whether the ratio between a person’s height and belly-button height is an example of the Golden Ratio. For this activity students undertake a similar investigation using data from the CensusAtSchool questionnaire.

Note: the version of Excel used is Excel 2003. The functions in the version of Excel you use may be in different locations but you will still be able to perform the same operations. The locations of the features students are shown below in the HELP section.

The Investigation

- 5.** Download your own sample of data using the CensusAtSchool random sampler.
- 6.** You will need to make decisions about the sample size, year level and sex of the students in your sample. You may even want to compare two different samples in your investigation.
- 7.** Copy and paste Height and Belly-Button data into a new Excel worksheet. If you want to compare boys with girls you will need to copy sex as well.
- 8.** Using the techniques outlined in Video no. 6 see if you agree that the height/belly-button height approximates the Golden Ratio.
- 9.** Write a report clearly stating the steps you followed and your conclusion. Include your data and graph.
- 10.** In your report, list the Excel functions you used to complete this investigation. Put an asterisk next to the ones you used for the first time.

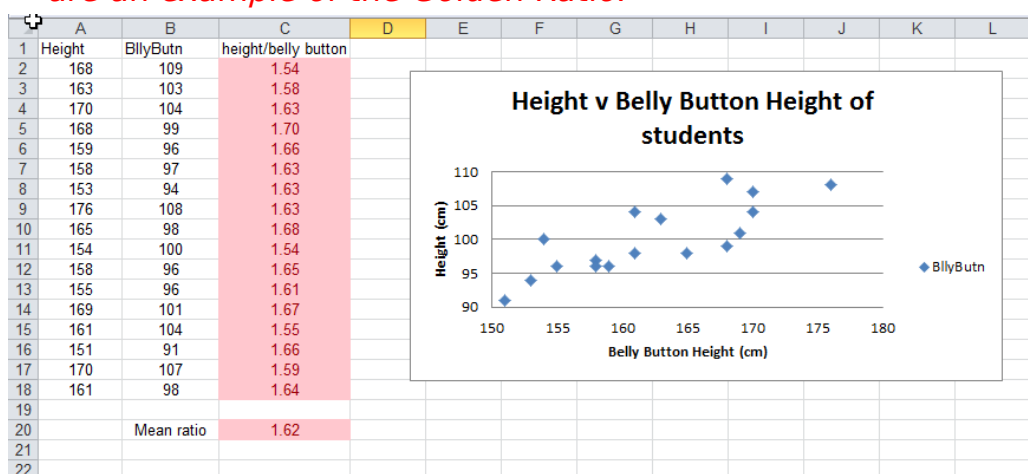
Teachers could use a checklist to ensure that students have included all necessary detail.

TEACHER SOLUTION

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E.g. Steps followed:

1. Decided parameters for sample and justified.
2. Took a random sample and copied into new Excel worksheet.
3. Ensured height was listed first as the dependent variable.
4. Set up a column to calculate height v belly- button ratio.
5. Used a formula to calculate ratio.
6. Used Fill Down for all values.
7. Determined a suitable range by which to identify outliers.
8. Used conditional formatting to highlight numbers outside this range.
9. Inserted a scatterplot of the relationship.
10. Scatterplot correctly labelled and axes formatted appropriately.
11. Trend line added to the graph.
12. Equation shown on the graph.
13. New Excel skills shown with an asterisk.
14. Clear report listing steps followed.
15. Data and graph included.
16. Clear conclusion stating whether height and belly-button height are an example of the Golden Ratio.

**Figure 1. Example of possible data set and scatter plot**

Excel 2010 Help

(Remember the Dependent variable always goes on y axis. For this activity, let height depend on belly-button height. This means belly-button height needs to be in the first column)

The version of Excel used in the video is Excel 2003. If you are using Excel 2010, the same features can be found by using the following:

- a. **To insert a scatterplot:** go to Insert > Scatter > choose the first plot
- b. **To label your graph:** Select graph then > Design>Chart Layouts> choose an option **or** go to Layout>Labels> Chart Title and Axis Titles

- c. To delete a row of data:** select data then >Home>Cells>Delete>Delete Sheet Rows
- d. To alter horizontal scale:** go to Layout > Axes > Axes> Primary Horizontal Axis > More Primary Horizontal Axis Options>Fixed
- e. To add a trend line and:** go to Layout>Analysis>Trend line>More Trend line **its equation** Options>select Linear >select Set Intercept = 0,0>select Display Equation on chart
- f. To find the mean ratio:** calculate height/ belly-button ratio in column C then choose a display cell and type =average (C2: C last cell) **or** Home>Editing> Σ > Average
- g. To COUNTIF:** go to Home>Styles>Conditional Formatting>Highlight Cell Rules>Between